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Assessment of Technology Transfer Process in Iranian Power Industry

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Abstract

One of the problems facing industries in developing countries is lack of effective transfer of imported technology and the most important reason of this shortcoming is that technology transfer processes are not gone through properly. Despite some barriers and problems associated with technology transfer from an industrial country to a developing country, if the transfer is not designed and prepared based on a technology plan, the developing country could achieve the technology by properly going through technology transfer processes. However, the most important point is that proper and successful transfer of technology is achieved when all processes of technology transfer are followed properly and successfully. Also, achievement of technology transfer process is evaluated by some comprehensive assessments. In the present study, after a review of literature about technology transfer, a pattern for technology transfer process is proposed in Mapna Company, which is the largest Iranian power industries company, and achievement of technology transfer process in Mapna Company is evaluated based on the pattern.

Keywords: technology, technology transfer, technology transfer process

Introduction

Technology is a fundamental factor in creating wealth, power, and knowledge in countries and institutions, and it is a powerful tool for countries' national development. That is why military war has been replaced by technological economic war. Therefore, it is very important to adopt strategies for technology transfer and development. Assessment and selection of technology is one of the most substantial activities for technology transfer, because in some cases an ill-considered selection of technology can bring about irreparable consequences.

Technology transfer is a systematic transfer of information associated with product manufacturers, application of products techniques, and offering services. Technology transfer channel covers two aspects: The first one is importing foreign technology and the second is applying domestic technology. Through importing foreign technology, economic institutions in developing countries could reduce risk for research and development, minimizing the gap between themselves and advanced countries (Li & Wei, 2012).

Technology transfer refers to the transfer and displacement of all factors and elements of technology from transferring side to the technology receiving side. In most cases, these factors and elements are not properly transferred to receiver countries, leading to some critical problems. In other words, industrial countries transferring technology have not much interest to submit technology to developing countries.

Despite some barriers and problems associated with proper technology transfer from an industrial country to a developing country, if the transfer is not designed and prepared based on a technology program, the developing country could achieve the technology by following the technology transfer process properly. However, the most important point is that proper and successful transfer of technology is achieved when all processes of technology transfer is gone through properly and successively. So, developing countries should make proper technology transfer

possible by accurately managing the technology transfer process. Also, these countries and the institutions should be able to measure the achievement of the technology transfer process by some comprehensive assessments, and use the results arising from the assessments to make appropriate decisions.

Literature review

Technology may be defined as a body of knowledge, processes, tools, procedures and systems used in manufacturing products and providing services. In other words, technology is the operation procedure and a tool by which we attain our objectives (Khalil, 2000).

Also, according to NASA, technology refers to a process through which utilizing technology peculiar to an organization (or a country) that has developed it, in an organization (or a country) and for other objectives is possible (Khalil, 2000).

Many definitions of technology transfer have been proposed by researchers. Foster (1971) points out two different ways of technology transfer: horizontal technology transfer which is the transfer of technical knowledge and innovation across projects, organizations, and industries, and vertical technology transfer which is the transfer of knowledge and innovation of sophisticated researches to develop it by commercialization. Camp and Sexton (1992) define technology transfer as a path for knowledge and technology including ideas and research results of the organization, initial fructification of the user organization, and commencement of centralized technological cooperation. Technology transfers in both approaches include achieving innovation from a foreign source as well as sharing technological knowledge for products, and processes (Park & Lee, 2011).

In general, technology transfer process has three phases and all phases should have been completed successfully to achieve proper transfer (Khamseh, 2005).

- Phase 1. Recognition and acquisition of technology. Issues addressed in this phase include:

1- Preliminary studies for recognition of technology, and relevant imported elements
2- Planning and design for the organization to select and acquire technology
3- Acquiring information for technology sources and its credible holder
4- Introducing design to the selected technology holders, and requesting information from them
5- Assessing and comparing recommendations
6- Selecting the appropriate recommendations and prioritizing them
7- Preparing for negotiations with the selected holders
8- Negotiating for acquisition of the most appropriate condition
9- Preparing and providing the final report
10- Concluding a contract

- Phase 2. Technology establishment. Issues in this phase include:

1- Preparing for entering to next phases
2- Receiving initial documents and evidences, reviews and preliminary checks; indicating shortages and doing required follow-ups to remove them
3- Adaptation step: process of accurately linking imported technology to the plan requirements and resources and conditions of the country
4- Absorption and analysis (mastering technology) step: full understanding of all components of the acquired technology by receiver
5- Implementation and utilization step: process of employing the acquired technology

- Phase 3. Technology maintenance. Topics for the phase include:

1- Development step: the process during which the knowledge resulting from the adjustment, absorption and application, experience, skill and findings for the internal researches, technology for better and newer processes and products are developed by using the acquired technology.

2- Technology diffusion: process of consideration and expansion of components of the acquired technology to all over the country

If all the above phases are completed successfully, it allows commercialization of the transferred technology. One of the problems associated with industries in developing countries is lack of effective transfer of imported technology and the most important reason for this is that technology transfer processes have not been observed properly.

In general, technology transfer involves the ability to apply, and to adjust, and in most cases, to innovate equipment and/or product processes, and finally technology transfer (i.e. exchange of capabilities and ideas underling it), whether to enhance the existing capability or to support industries for developing countries in design and development of products and processes.

Technology transfer models

Table 1 illustrates some proposed models for technology transfer together with their specifications. Of course, each model emphasizes on specific aspects of the transfer mechanism. Obviously, selecting a specific model and/or a combination of the existing models depends on some factors such as the associated industry, conditions of technology receiver, etc.

Table 1. Proposed models for technology transfer

Model	Components of model
1. General model for technology transfer (R.Phoal 2001)	-Assessment, identification, and selection of technology -Selecting the appropriate method or methods -Negotiating and preparing contract draft and final negotiations -Acquiring technology -Adjusting and absorbing, and localizing -Developing and innovating -Expanding
2. Tenkasi & Mohraman models (1995)	-The appropriateness of the given technology -The effective transfer is done when technical information regularly transferred from communication channels to technology receivers with minimum impediments -Effective transfer of technology knowledge to technology receiver -Developing technical knowledge and achieving innovation
3. Conceptual model for technology transfer (Johnson, Foster & Stachwell)	-Technological activities that lead to technology development and innovation -Obstacles to technology transfer and

	development -Phases for the technology transfer process
4. Industry & University Interaction Model	-Increasing dynamics for technology transfer or establishing an appropriate relationship between industry and research centers -Presenting beneficial projects by research centers to industry, immediate technical problem-solving in industry by theses centers -Technology transfer centers are the best means to communicate
5. Rutten & Haymai Model (2001)	-Technology transfer is implemented within the following three phases: -Transferring technical artifacts such as machinery, tools, and techniques for using them -Transferring design and plans including all plans, and blueprints to be used in transferred technology -Transferring technical knowledge
6. Malik Model (2002)	In this model, technology transfer has been compared to a message whose effective transfer depends on mutual understanding between message sender and receiver. That is, the message (technology in question) is the sent message or it is received properly and utilized effectively.
7. General model for technology transfer into developing countries (Moor 1999)	In this model, for the procedure of technology transfer, 6 main activities are considered: -Technology transfer as goods and/or products such as machinery, tools, plans, and/or mere information that should be gained for optimal use of the products. -Technology applications -Types of technology transfer -Methods for technology transfer -Effective factors (all environmental specifications and technological gap between receiver and sender) -Effectiveness of technology (technology transfer means transfer of cultural, political, etc. diversities)
8. Conceptual Model for technology transfer (Canadian International Development Agency 2004)	In this model, after transferring a certain technology, the organization has regular interaction with market to know about customers' needs. Within the interaction,

	after accessing software and hardware of technology and market feedbacks, the organization can acquire technological capabilities that will gradually result in development and innovation of transferred technology consistent with market needs and native culture.
9. Effective technology transfer model	It is a customer-centered model surrounded with phases of technology transfer to market in which technologists are involved. These cases include marketing, selling, implementing and follow-up. In establishing good relations with customers (market), technologists play an important role to offer technology according to customers' needs.

Developed Pattern for Technology Transfer

Considering the literature review and as well as other models already proposed, the conceptual model for technology transfer is described according to Fig 1.

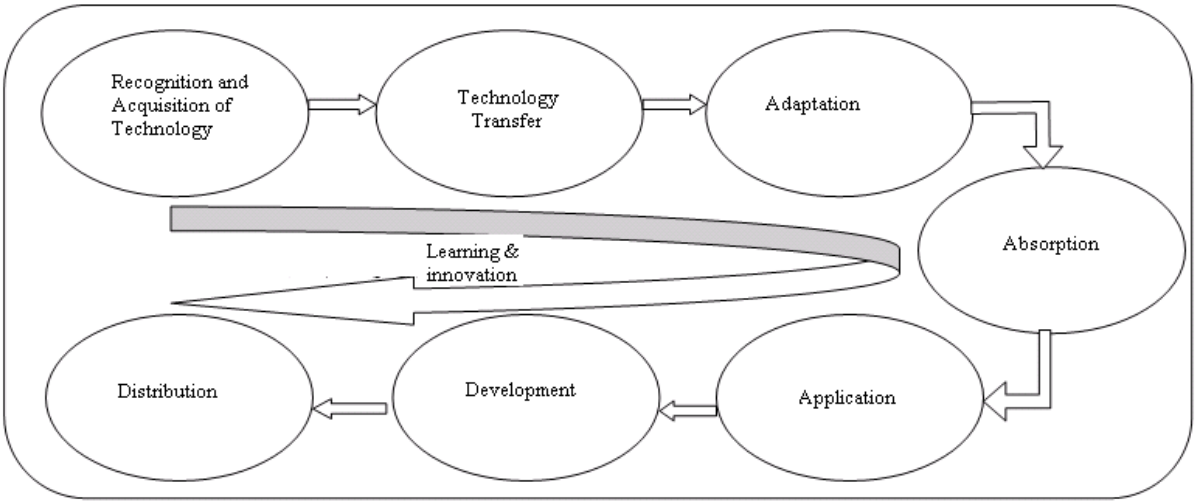

Figure 1. Conceptual Model for Technology

According to the above model, proper technology transfer process in Mapna Power Industries is implemented within three general phases. Also, according to Fig. 2, we would have 7 main phases to assess technology transfer process based on the above model. Considering Figs 1 and 2, tree for relations of indices for technology transfer model that is the base for assessment of technology transfer process is illustrated in Fig 3. Also, the questions of the research questionnaire were formulated based on tree relations, and its validity was confirmed by experts' judgment. Reliability of the questionnaire was determined by Cronbach's alpha coefficient and was found to be 0.86.

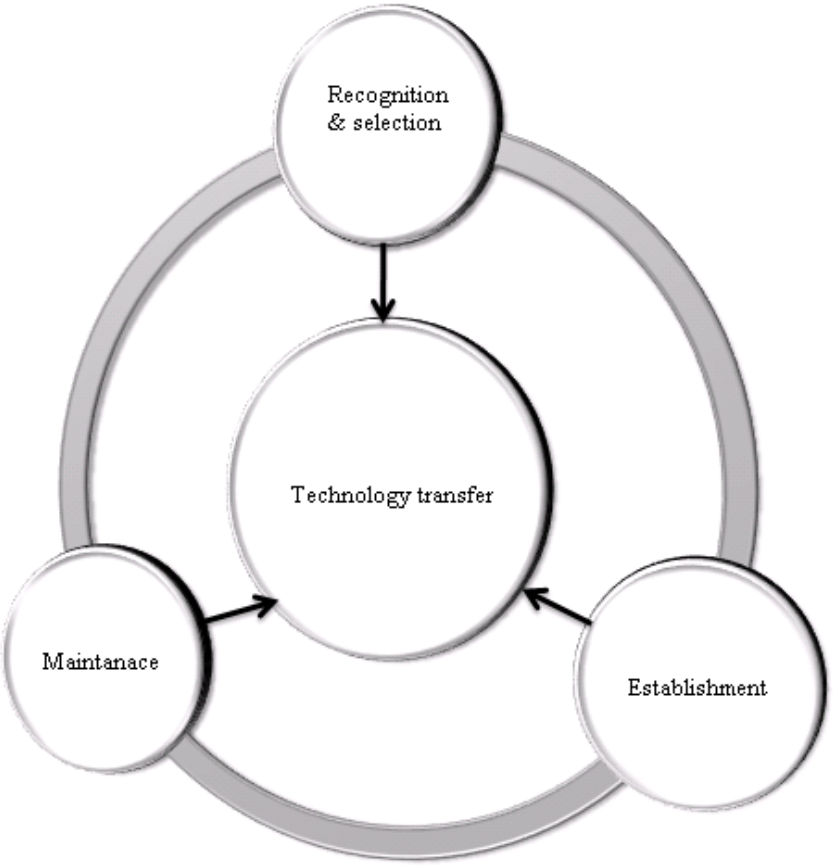

Figure 2. Main phases (aspects) of technology transfer process

Research Questions

First question: To what extent has the imported technology transfer process been successful in technology transfer projects of Mapna Company?

Second question: How different is any phase of technology transfer in Mapna Company from the ideal level?

Materials and Methods

This research is applied in terms of objective and it is a field study because the information was collected within the organization using a questionnaire. Since this research was conducted in Mapna Company that operates in power industry, it is then a case study.

Statistical population

Specifications for statistical population of this research that was selected purposefully from experts of Mapna Company are given in Table 2.

Table 2. Academic Profile and Employment History for those filling questionnaire

Education	Number	Percent from total	Employment history (yr)
Bachelor	9	15	11.5
MA	45	75	46
Total	60	100	11.38

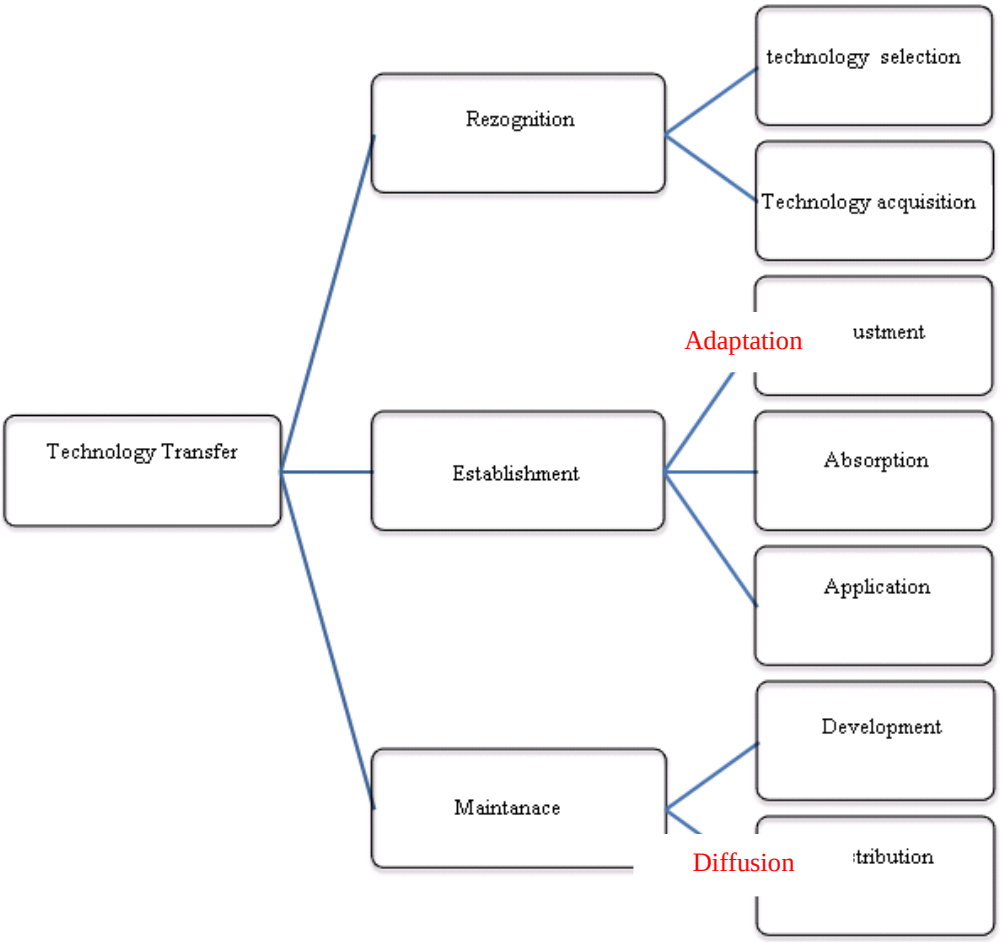

Figure 3. Tree for relations of indices for technology transfer process

Table 3. Achievement rate of technology transfer process

Technology transfer steps	Phases in any step	Achievement percentage for phases	Achievement percentage for steps
Technology recognition and acquisition step	Identification and selection	65.4	64.9
	Acquisition	64.4	
Establishment step	Adaptation	54.3	62.7
	Absorption	63.6	
	Application	70.2	
Technology maintenance step	Development	66.1	51.6
	Diffusion	37.1	
comprehensive achievement rate for the whole process of technology transfer		60.16	

Findings of the study

Q1: regarding the results of questionnaires, achievement rate of technology transfer process for each of research dimensions, and also achievement rate of the whole technology transfer process in Mapna Company have been summarized in Table 3.

Q2: through interviews with senior experts of the company, the ideal levels of achievement for technology transfer projects in Mapna Company with respect to organizational maturity as well as experiences of transferred technologies was determined to be 75%. The results are given in Table 4 and Diagram 1.

Table 4. Comparison of the current capability with the ideal level for any index

Technology transfer steps	Phases	The existing gap into 75%	Average gap
Technology recognition and acquisition step	Identification and selection	34.6	35.1
	Acquisition	35.6	
Technology Establishment step	Adaptation	45.7	37.3
	Application	29.8	
Technology maintenance step	development	33.9	48.4
	Diffusion	62.9	
Achievement rate for the whole process of technology		39.84	

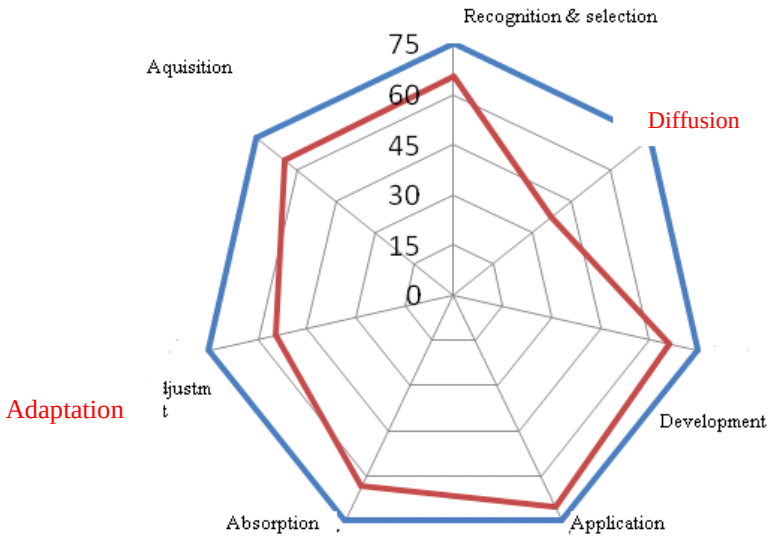

Figure 4: Comparison of the current achievement for technology transfer with the ideal level

Results

Technology transfer is a complex and difficult process and it will not be useful without necessary study and review, otherwise, it can lead to diminished national technology and wasting capital and time.

The results coming from the first main question of the research regarding achievement rate for the imported technology transfer process in technology transfer projects of Mapna Company, according to Table 3 indicate that achievement rate of the whole technology transfer process equals 60.16%, while from among various steps of technology transfer process, stage of technology

recognition and acquisition by 64.9% has the highest achievement rate and technology maintenance stage by 51.6% has the lowest achievement rate.

Also, from among phases for the technology transfer process, application phase (70.2%) has the highest, and Diffusion phase (37.1%) has the lowest achievement rate.

The results coming from the second question of the research regarding the technological difference rate in any step of technology transfer in Mapna Company indicate that the stage of technology recognition and acquisition (35.1%) has the lowest difference (gap) from ideal, while maintenance (48.4%) has the highest difference (gap). Also, from among technology transfer phases, Diffusion phase (62.9%) has the highest difference (gap), and application phase (29.8%) has the lowest.

Considering the observed statistics, in cases that the grades have a relatively more difference (gap) from the ideal state, the following recommendations could be offered:

- Employing some consultants and establishing research centers in technology transfer projects.
- Designing a system to select suppliers according to the imported technologies.
- Diffusion imported technology by transferring ire across companies via formal methods for technology transfer, and concluding contracts throughout the country.

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